

3. *Aonyx*. Muffle bald, oblong, transverse; claws rudimentary; soles half naked. *A. Horsfieldii*, *A. aurobrunnea*, *A. indigitata* of India, and *A. Lalandii* of South Africa.

4. *Latax*. Muffle bald, large, oblong, triangular, angular above; claws distinct; soles hairy. *L. Lataxina*.

B. *Hind feet large.*

5. *Enhydra*. Tail short, cylindrical; muffle bald, oblong, triangular; soles entirely hairy. *E. marina*.

6. *Pteronura*. Tail elongate, with a fin on each side. *P. Sanbachi*.

XXII.—*History and Observations on the Pearly Nautilus, involving a new Theory to account for the camerated construction of its Shell by the aid of the Siphonic Membrane.*  
By Mr. LOVELL REEVE, A.L.S.\*

THE two great conchiferous Cephalopods, *Argonauta* and *Nautilus*, seem to have been equally well known to the father of natural history; for in Scaliger's translation of the 'Historia Animalium' we learn that Aristotle, when speaking of his *Polypi*, or *Cephalopodous Malakia*, makes especial mention of two of them having shells. They were both regarded by this venerable philosopher as species of *Nautilus*; "the one," says Aristotle, "has a hollow shell, not naturally adherent to it; the other has a shell, which like a snail it never quits." Here, however, remained the history of these mollusks for ages. Pliny, and indeed other writers subsequent to Aristotle, seem only to have noticed one of the *Nautili* of their predecessor, for their observations embody little beyond what he had transmitted to them of his *Nautilus primus*, the light monothalamous *Argonaut* of Linnæus. The *Nautilus secundus* of the ancients remained in obscurity until the revival of letters; Belon, a French author of 1550, gave a representation of the shell; and its animal inhabitant was figured in 1703 by Rumphius, a Dutch merchant and naturalist resident at Amboyna. Although an accurate delineator of character for the age in which he lived, he was no anatomist, and his drawings are somewhat inaccurate; having lost his sketches, he is said to have renewed them from recollection; they have, however, been valued from necessity, for no other living specimen of this mollusk was discovered for the lapse of a century and a quarter.

Cuvier, the first great anatomist who tested the organism

\* From Mr. Lovell Reeve's valuable work on the Mollusca.

of the Cephalopods by minute dissection, looked with earnest solicitude, no doubt, for the soft and living portion of the *Nautilus*; but the act which made at last so prominent a step in the history of these animals was reserved for a no less skilful operator of our own day. A *Nautilus* was captured in 1829 in the Bay of Marekini, at the Island of Erromango, New Hebrides; it was seen floating on the surface of the water, and was just about to sink, when a sailor caught hold of it with a boat-hook. The right eye was almost shattered in the struggle to secure it, and the shell being much broken it was injudiciously removed. Two years unfortunately elapsed before the soft parts, which were carefully preserved in spirits, reached England: they were presented to Mr. Owen for dissection; and although a minute portion of shell, adhering to one of the lateral expansions of the belt, was all that remained of the original frame-work, he admirably succeeded, by a train of analogical reasoning, to establish the relation of the whole. His celebrated 'Memoir on the Pearly *Nautilus* \*' was published in London in 1832 by the Royal College of Surgeons, and to the severe disappointment of the author, the illustrious Cuvier died but a few days before it issued from the press.

Although the animal of the *Nautilus* was an important acquisition to conchological science, it would have been far more acceptable if accompanied with the shell: a doubt immediately arose amongst naturalists, as to whether the position which Mr. Owen had assigned to the animal in the shell was the true one. "*Mais dans quelle position,*" asks De Blainville, "*le Nautil est-il dans sa coquille?*" "*And if,*" says Mr. Gray, "*the relative position of the animal of the Nautilus be correctly assigned by Mr. Owen with respect to its shell, it must offer a similar anomaly to the genera Patella and Lottia.*"

In 1840 two more specimens of the *Nautilus* were procured after a long and arduous search, by a Dutch gentleman at New Guinea. One was sent to the public museum of Leyden, and the other to Paris; but as these also were destitute of their calcareous envelope, an investigation of them could add little to what had been already advanced by Mr. Owen. M. Valenciennes, however, with a laudable desire, probably, of emulating his predecessor, undertook the dissection, and a skilful

\* The very elaborate character of this memoir directly stamped its author as the first zootomist of the day. The smallest nerve has its immediate office assigned to it, the simplest organ its peculiar function; the component systems are traced with the most rigorous accuracy, and the inferences that are deduced from a consideration of the whole, exhibit a fertility of imagination that renders an abstruse subject as pleasing as it is full of scientific interest.

memoir was the result, though not containing much of novelty beyond a difference in his calculation of the tentacles, and the demonstration of an organ of hearing\*. His observations are conducted with accuracy and plainness, but the memoir is not so rich in that eloquent analogical reasoning which so vividly characterizes the writings of his contemporary. The opportunity that was thus afforded the continental professor of examining the soft parts of the Nautilus, was highly satisfactory to Mr. Owen, for he arrived at precisely the same conclusion as himself in regard to their relation with the shell. "*En confirmant,*" says Valenciennes, "*la manière de voir de M. Owen, si juste et si conforme à la nature, j'ai établi l'animal dans la vraie place occupée par lui dans sa coquille, je ne laisse plus aucune discussion raisonnable possible sur ce point.*" Here, however, was no direct proof, the testimony of both the learned professors was alike circumstantial; indeed, the very necessity for the introduction of the word *raisonnable* in this statement proclaimed it to be an hypothesis. Mr. Owen was himself singularly destined to prove the truth of his conjecture, for only two days since a magnificent specimen of the Nautilus, with its shell entire, was presented to him by Capt. Belcher, R.N. The individual in question was captured by that gentleman at Amboyna, not long since; it was secured alive, and has been preserved, together with its shell, in spirits without the slightest injury. When put into Mr. Owen's hands, he was extremely gratified to behold that the animal held exactly the position in its shell that he had ventured to assign to it; and we doubt not but that M. Valenciennes will be as highly pleased to find that his expectations have been so soon realized †.

Having detailed the history of the Nautilus from the time of Aristotle to the present day, it now remains for us to speak of its structure and general habits. The soft parts of this animal form a kind of oblong mass, such as may be supposed capable of fitting into the porch or aperture of its well-known shell, and, like the rest of the Cephalopods, consist of two

\* Mr. Owen says on this head, "With respect to the sense of hearing, I have not been able to detect a distinct organ for that faculty."

† We shall not readily forget the glorious delight of the Hunterian Professor, as he hurried past our door only yesterday on his way to the Zoological Society; his treasure proudly suspended in an anatomical jar; himself loaded with the controversial theories of his contemporaries, that he was about to level at a breath. Nor can we fail to remember his animated enthusiasm at the Meeting, when, holding up the precious truant, fresh as it were from its native element, without a fracture, and apparently dozing under its capacious hood, he proved, beyond the possibility of contradiction, the generalizations he had so admirably worked out as a student ten years before by an ingenious complication of analogies.

parts. The anterior or outer part incloses a well-developed head, with a pair of strong, horny mandibles, a mass of some thirty or forty tentacles, and a number of delicate structures, including the organs of smelling, hearing, seeing, &c.; and over all these parts is a capacious fleshy hood, which may be considered as the analogue of the operculum in the Gastropods. The inner or posterior part of the body contains the viscera, with a funnel or vent-hole extending from beneath the tentacles, and the entire abdominal mass, together with the breathing apparatus, is enveloped by a large sack-like mantle fitting into the hollow of the shell. The anterior portion of the mantle, or that which is attached to the back part of the head, is produced into a considerable fold, which overlaps the involuted convexity of the shell, and from the lower extremity of the entire body extends a central membranous tubiform process, which, by passing the siphonic apertures of the septa, extends completely through the convolutions of the shell, from chamber to chamber, until it is fastened to the nucleus or parietal wall of the central or first-formed chamber. Around the circumference of this abdominal sack there is a thin layer of horny matter, called the belt, expanding on each side into a kind of broad patch, and becoming the medium of muscular attachment.

The natural position, then, of the Nautilus in its shell, is with the back of the head and concavity of the hood against the camerated convexity of the spire, and the funnel resting on the outer concave wall of the chamber: the tentacles are consequently protruded over the lateral margins of the aperture, and the body is retained within the shell by the adhesion of the membrane and the horny girdle.

The following appears to us to be the manner in which the Nautilus constructs its shell. The animal in its embryo formation deposits a simple hollow shell, out of which it necessarily advances as it increases in bulk; and in order to assist its specific gravity at the bottom of the ocean, the vacated portion of the shell is chambered in by the secretion of transverse septa, the animal having first taken the precaution to secure a strong tubiform membrane to the inner wall, in order to adjust its position (a consideration of the habits of this pelagic mollusk will show the necessity for this membrane). As the soft parts increase in bulk, the muscular girdle which binds them to the shell would naturally be forced from any adhesion; but from its being furnished with a certain degree of elasticity, it advances by a series of periodical slips, the suddenness of which is undoubtedly counteracted by the attachment of the central membrane. The growth of the shell

then proceeds in a circular direction, and serves to buoy up its inhabitant in the water by having the vacated portion chambered in to meet its specific gravity. The geometrical increase of it arises simply thus. The natural position of the Nautilus, like other Cephalopods, is with its head downwards, the shell being consequently above; and the periodical slip of the belt of adhesion most probably takes place when the animal is in this supine position. It lets itself down, and round and round, as it were, upon its axis, by the limited extension of this membranous pulley; the operation ceases when it arrives at maturity, and the membrane being no longer wanted, probably decays. Such is the manner in which our observations lead us to suppose the Nautilus grows; the chambers have certainly no communication with the surrounding fluid. The camerated portion of the shell of Nautilus is evidently a simple, mechanical construction, (though planned by the wisest intelligence,) to assist the specific gravity of its inhabitant whilst under the different mutations of pressure that it is liable to at different periods of growth in its passage through the element; and it is, moreover, a contrivance that could only be effected by the aid of this adjusting membrane upon the simple geometry of motion above described\*.

M. Valenciennes regards the periodical introduction of a partition in the shell of Nautilus as in some measure analogous to the occasional deposit of a varix in the shell of *Murex* and other Gastropods. The septa, like the varices, may undoubtedly be secreted by the mantle during a period of rest, but there the analogy ceases. We would rather compare the rotatory increase of the Nautilus to the horizontal growth of that singular Gastropod, the *Magilus* (Conch. Syst. p. 231). The one gravitates round a centre, increasing by a peculiarity of con-

\* The principle here advanced, of the geometrical formation of the Nautilus shell round its axis by the aid of an adjusting membrane, and of its camerated construction being accommodated to the specific gravity of the inhabitant, will, perhaps, receive additional weight by a consideration of the following passage from the 'Memoir' of Professor Owen:—

“In sections of recent shells, its [the membrane's] dried remains may occasionally be seen of a black colour and pergameneous texture, continuing from septum to septum as far as the central or first-formed chamber; and a further confirmation that this is the true structure of the parts, is afforded by the fossil shells of this genus. In some polished sections of these remains, not only is the continuation of the tube through all the chambers evident, but it is seen to become slightly dilated in them, and in some instances appears also to have been reflected over the outer part of the testaceous tube prior to being continued across the chamber to the next partition. There is no indication, however, of the latter structure in the recent shells where the membranous tube is preserved.”

trivance the volume and comparative buoyancy of its shell to keep pace with the surrounding pressure, which naturally increases in intenseness as the subject increases in bulk; the other having a different medium to combat with, namely, the outward increase of the coral in which it is imbedded, leaves its spiral plan of construction to pursue a straight growth, and, raising itself forward, fills the vacated portion of the shell with an extraordinary secretion of solid matter. If the *Margilus* had advanced by a deposit of transverse septa, instead of solidifying its shell, the increase of the madreporite might have crushed it; and if the *Nautilus* had advanced by the solidifying of its shell instead of by the deposit of transverse septa, it would have produced an incumbrance incompatible with its locomotive faculties.

We are now brought to the consideration of the habits of the Nautilus. It is evidently, as Mr. Owen expresses it, "a ground-dwelling animal," creeping along the bottom of the sea, with hood and tentacles, at a tolerably quick pace; and the shell, being above its head, must greatly assist the animal in its movements, from a tendency to float. It is not improbable but that the Nautilus may use a certain hydrostatic influence over the branchial cavity to enable it to rise to the surface. Valenciennes says, "*Il nage avec facilité dans le sein des eaux en faisant sortir avec force la grande quantité d'eau contenue dans sa cavité branchiale.*" And the testimony of Rumphius in respect to its capacity of floating, cited by Mr. Owen, is of so much interest, considering the time in which it was written, that we venture to repeat it.

"When he thus floats on the water, he puts out his head, and all his barbs (tentacles), and spreads them upon the water with the poop (of the shell) above; but at the bottom he creeps in the reverse position, with his boat above him, and with his head and barbs upon the ground, making\* a tolerably quick progress. He keeps himself chiefly upon the ground, creeping sometimes also into the nets of the fishermen; but after a storm, as the weather becomes calm, they are seen in troops floating on the water, being driven up by the agitation of the waves: whence one may infer that they congregate in troops at the bottom. This sailing, however, is not of long continuance; for having taken in all their tentacles, they upset their boat, and so return to the bottom." This account, published at Amsterdam more than a hundred years ago, is mainly authenticated; but it may still be a little exaggerated, for the

\* By force of gravity probably.

*Nautili* have never since been found floating in troops, nor exercising the bold familiarity, above-mentioned, of walking into the fisherman's nets.

The natural history of this mollusk is important to the *zoologist*, but far more so to the *geologist*. The mysterious nature of those polythalamous tenants of a former world, the *Ammonites* and their multifarious congeners, is at length demonstrated by the discovery of the *Nautilus*, a solitary living remnant, proving that the vast assemblage of those organic remains so abundant in our secondary formations must have belonged to animals who once dwelt in full activity and vigour at the bottom of the ocean, constructing a discoidal shell by force of gravity, and hermetically sealing the vacated portion of it as they increased in bulk, to give them buoyancy under the surrounding pressure\*.

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XXIII.—*History of a Case in which a Fluid periodically ejected from the Stomach contained Vegetable Organisms of an undescribed form.* By JOHN GOODSIR, Esq., Conservator of the Royal College of Surgeons in Edinburgh †.

THE case detailed by Mr. Goodsir is that of a young man, aged 19, who had laboured for four months under stomach complaint, accompanied with the ejection of a peculiar acid fluid from the stomach. The fluid passed from the stomach every morning without any effort of vomiting. On examining the ejected fluid with the microscope, peculiar organisms were detected, in the form of square or slightly oblong plates. "The flat surfaces were divided into four secondary squares by two rectilinear transparent spaces, which, passing from side to side, intersected one another in the centre, like two cross garden-walks. Each of the four secondary squares was again divided by similarly arranged, but more feebly developed spaces, into four ternary squares. The sixteen ternary squares thus constituted, when examined with deeper powers, were seen to consist each of four cells, which were not separated by transparent spaces, but simply by dissepiments formed by the conjunction of the walls of contiguous cells. These sixty-four cells, of which the organism consisted, did not present in perfect individuals distinct nuclei." The whole organism had the appearance of a wool-pack, or of a soft bundle bound with cord, crossing it four times at right angles and at equal distances: hence Mr. Goodsir gives it the name of *Sarcina*. He considers it to be of a vegetable nature, and to be allied to some of the

\* "The *Nautilus*," says Prof. Owen, "is the living, and perhaps sole living archetype of a vast tribe of organized beings, whose fossilized remains testify their existence at a remote period, and in another order of things."

† From the Edinburgh Medical and Surgical Journal, No. 151.